**Summary**

**Candidate’s name** – Sonya Thadikaran

**Title of concept** – Nuclear Reactions

**Back Ground Information –** Teachers and students should read the following articles to get a better idea of nuclear reactions.

“A **nuclear reaction** is the process in which two [nuclei](http://en.wikipedia.org/wiki/Atomic_nucleus), or else a nucleus of an atom and a [subatomic particle](http://en.wikipedia.org/wiki/Subatomic_particle) (such as a proton, or high energy electron) from outside the atom, collide to produce products different from the initial particles. In principle, a reaction can involve more than three particles colliding, but because the probability of three or more nuclei to meet at the same time at the same place is much less than for two nuclei, such an event is exceptionally rare.”

Reference - <http://en.wikipedia.org/wiki/Nuclear_reaction>

**“Nuclear fission** is a [nuclear reaction](http://en.wikipedia.org/wiki/Nuclear_reaction) in which the [nucleus](http://en.wikipedia.org/wiki/Atomic_nucleus) of an atom splits into smaller parts (lighter [nuclei](http://en.wikipedia.org/wiki/Atomic_nucleus)), often producing free [neutrons](http://en.wikipedia.org/wiki/Neutron) and [photons](http://en.wikipedia.org/wiki/Photon) (in the form of [gamma rays](http://en.wikipedia.org/wiki/Gamma_ray)), and releasing a tremendous amount of [energy](http://en.wikipedia.org/wiki/Energy).”

Reference - <http://en.wikipedia.org/wiki/Nuclear_fission>

“Nuclear fission produces energy for [nuclear power](http://en.wikipedia.org/wiki/Nuclear_power) and to drive the explosion of [nuclear weapons](http://en.wikipedia.org/wiki/Nuclear_weapon). Both uses are possible because certain substances called [nuclear fuels](http://en.wikipedia.org/wiki/Nuclear_fuel) undergo fission when struck by fission neutrons, and in turn emit neutrons when they break apart. This makes possible a self-sustaining [chain reaction](http://en.wikipedia.org/wiki/Chain_reaction) that releases energy at a controlled rate in a [nuclear reactor](http://en.wikipedia.org/wiki/Nuclear_reactor) or at a very rapid uncontrolled rate in a [nuclear weapon](http://en.wikipedia.org/wiki/Nuclear_weapon).”

**Nuclear fusion** is the process by which two or more [atomic nuclei](http://en.wikipedia.org/wiki/Atomic_nuclei) join together, or "fuse", to form a single heavier nucleus. This is usually accompanied by the release or absorption of large quantities of [energy](http://en.wikipedia.org/wiki/Energy). Fusion is the process that powers active [stars](http://en.wikipedia.org/wiki/Star), the [H-bomb](http://en.wikipedia.org/wiki/H-bomb) and experimental devices examining [fusion power](http://en.wikipedia.org/wiki/Fusion_power) for [electrical generation](http://en.wikipedia.org/wiki/Electrical_generation).

<http://en.wikipedia.org/wiki/Nuclear_fusion>

The fusion of two nuclei with lower masses than [iron](http://en.wikipedia.org/wiki/Iron) (which, along with [nickel](http://en.wikipedia.org/wiki/Nickel), has the largest [binding energy](http://en.wikipedia.org/wiki/Binding_energy) per nucleon) generally releases energy, while the fusion of nuclei heavier than iron *absorbs* energy.

**Differences between nuclear fusion and nuclear fission**

| **Nuclear Fission** | **Nuclear Fusion** | [**Show All**](http://www.diffen.com/difference/Nuclear_Fission_vs_Nuclear_Fusion) |
| --- | --- | --- |
| **Natural occurrence of the process:** | Fission reaction does not normally occur in nature. | Fusion occurs in stars, such as the sun. |  |
| **Byproducts of the reaction:** | Fission produces many highly radioactive particles. | Few radioactive particles are produced by fusion reaction, but if a fission "trigger" is used, radioactive particles will result from that. |  |
| **Energy Ratios:** | The energy released by fission is a million times greater than that released in chemical reactions; but lower than the energy released by nuclear fusion. | The energy released by fusion is three to four times greater than the energy released by fission. |  |
| **Nuclear weapon:** | One class of nuclear weapon is a fission bomb, also known as an atomic bomb or atom bomb. | One class of nuclear weapon is the hydrogen bomb, which uses a fission reaction to "trigger" a fusion reaction. |  |
| **Definition:** | Fission is the splitting of a large atom into two or more smaller ones. | Fusion is the fusing of two or more lighter atoms into a larger one. |  |
| **Conditions:** | Critical mass of the substance and high-speed neutrons are required. | High density, high temperature environment is required. |  |
| **Energy requirement** | Takes little energy to split two atoms in a fission reaction. | Extremely high energy is required to bring two or more protons close enough that nuclear forces overcome their electrostatic repulsion. |  |

<http://www.diffen.com/difference/Nuclear_Fission_vs_Nuclear_Fusion>

Chain Reaction

A **chain reaction** is a sequence of reactions where a reactive product or by-product causes additional reactions to take place. In a chain reaction, [positive feedback](http://en.wikipedia.org/wiki/Positive_feedback) leads to a self-amplifying [chain of events](http://en.wikipedia.org/wiki/Chain_of_events).

The main steps of chain reaction are the following.

* Initiation (at this step an active particle, often a [free radical](http://en.wikipedia.org/wiki/Free_radical), is produced);
* propagation (may comprise several elementary steps, as, for instance, reaction elementary acts, where the active particle through reaction forms another active particle which continues the reaction chain by entering the next elementary step); particular cases are:

\* chain branching (the case of propagation step when more new active particles form in the step than enter it);

\* chain transfer (the case in which one active particle enters an elementary reaction with the inactive particle which as a result becomes another active particle along with forming of another inactive particle from the initial active one);

* termination (elementary step in which active particle loses its activity without transferring the chain; e. g. [recombination](http://en.wikipedia.org/wiki/Recombination) of the free radicals).

<http://en.wikipedia.org/wiki/Chain_reaction>

Applications and CANDU reactor back ground information can be obtained from NELSON GRADE 12 chemistry text book and Inorganic Chemistry 3rd edition By Peter Atkins.

Advance preparation

Teacher must call the guest speaker and arrange beforehand a suitable field trip to one of the sustainable energy plants.

Teacher must ask the recycling team at school and other classes to donate their cloth, used icecream sticks, paper, odds and ends for the model of the nuclear reactor.

Teacher must preplan the group members and dynamics to ensure smooth, unintertupted transition into the next activity.

**Special Materials**

A lot of so called “junk” must be collected to create the models. This helps to reinforce the concept of reusing, recycling and reducing.

**Student Difficulties**

* The greatest difficulty students would face is believing that nuclear power is always inherently harmful and that nuclear power can never be used for the good of humanity.
* Another misconception they would have is to believe that alternative energy usage is a vague, and impractical concept.

Teaching Ideas

This would include field trip, demonstration, computer simulation, debates

Evaluation

My evaluation would consist of written reports on their field trip, letter writing, oral presentation, skit, summary on a moodle, construction of a nuclear power planet model.

Applications and practical applications

Electricity- generation of a “clean” source of energy for homes

Space- space missions in space propulsions

Heating systems – For homes, factories and offices

Lesson sequence

* When students walk into class, they are greeted with a video playing on the LCD monitor showcasing nuclear reactions.
* They are asked to sit down quickly, ask no questions, given 5 minutes to watch the video and write on a piece of paper what they believe the video is about.

<http://www.youtube.com/watch?v=HmbzJGf90Xc>

<http://www.youtube.com/watch?v=vDAZsPkTkMM&feature=related>

Once this is done, they are asked to exchange the information sheets with their peers and each person reads one line from their friends sheet and a discussion ensues.

* Teacher leads the discussion with the definition of Nuclear power and shows a chart with the division of nuclear power into its components.
* Teachers then tells students to imagine that they are a nuclear scientist and use the computer simulation to make sure their reactor doesn’t have a MELTDOWN!!!!!

<http://esa21.kennesaw.edu/activities/nukeenergy/nuke.htm>

An individual report is submitted to the teacher of today’s class room understanding.

* 2 random students are asked to recap to the class the activities and knowledge of day 1 of this concept as revision.
* Teacher organises students into groups of 5 each and organises the jigsaw strategy of learning. Each student of the group will research 1 point about nuclear fusion and one point about nuclear fission. Then, the members meet together and collaborate their results and submit their findings as a group oral presentation. Teacher clarifies the points and explains in a bit more detail.
* Students are then asked to imagine that they are concerned citizens and write a letter to the prime minister highlighting why they believe nuclear fission is the energy of the future or why they believe that nuclear fusion is the energy of the future.

Students submit the letter for evaluation.

* Teacher asks students to get into groups of 5 and organize a skit on the applications of nuclear power.
* After this actvity, the teacher introduces a scientist from the CANDU plant who will answer students questions and show a power point presentation of the internal workings of the lab.
* Then,Chain reaction is taught by the following simulation.

Teacher organises a debate with 10 students for nuclear power and 10 students against nuclear power after students research in their own groups using these sites and books.

* Visit to a alternative energy plant and a field trip report illustrates the importance of being open to energy alternatives for the well being of our planet.
* Teacher revises the nuclear energy concept by a quiz show activity and she concludes by an assessment of a student’s moodle where the student has to prepare a summary of the points in the chapter and teacher corrects.

References

- <http://en.wikipedia.org/wiki/Nuclear_reaction>

<http://www.youtube.com/watch?v=HmbzJGf90Xc>

<http://www.youtube.com/watch?v=vDAZsPkTkMM&feature=related>

Nelson Chemistry Grade 12

<http://esa21.kennesaw.edu/activities/nukeenergy/nuke.htm>

<http://en.wikipedia.org/wiki/Chain_reaction>

Inorganic Chemistry – 3rd edition- Peter Atkins

<http://www.diffen.com/difference/Nuclear_Fission_vs_Nuclear_Fusion>